IOOS® INTEGRATED OCEAN OBSERVING SYSTEM

OCEAN TECHNOLOGY TRANSITION – MARINE SENSOR AND ADVANCED OBSERVING TECHNOLOGY TRANSITION

FY13 Project Details

In FY2013, the U.S. IOOS Program (IOOS®) instituted a multi-year Ocean Technology Transition project to advance science and technology and better enable decision-making. Two efforts were selected for funding in the first year of the project:

1) transitioning new ocean acidification sensor technology to support shellfish industry monitoring needs and develop the technical workforce's capacity to work with these sensors ($604,420), and

2) transitioning the Environmental Sample Processor (ESP) for harmful algal bloom monitoring ($340,000).

Details of these efforts are provided below.

I. Ocean Acidification

The NOAA Ocean Acidification (OA) Program and U.S. IOOS jointly developed a series of activities across the West Coast, Alaska, and Hawaii to support ocean acidification sensor development and applications to provide information about ocean acidification for protection of the shellfish industry. Partners include U.S. IOOS Regional Associations (RAs) – Northwest Association of Networked Ocean Observing Systems (NANOOS), Central and Northern California Ocean Observing System (CeNCOOS), Southern California Coastal Ocean Observing System (SCCOOS), Alaska Ocean Observing System (AOOS), Pacific Islands Ocean Observing System (PacIOOS), and NOAA's Pacific Marine Environmental Laboratory (PMEL).

Activities fall into four categories:

1. Development and application of state of the art monitoring technologies for shellfish hatcheries and growers in Washington and Oregon. The focus will be on developing an open water, nearshore mooring (recipients will build and deploy two prototypes) which measures relevant ocean acidification parameters throughout the water column and reports in near real time. The challenge is developing a mooring that can withstand the temperature extremes which exist in nearshore, shallow water temperate systems. Monitoring equipment prototypes will be deployed and tested in Puget Sound (deployed at Dabob, Twanoh, Hood Canal or South Puget Sound locations – all of which are relevant for local shellfish industries). The prototype mooring, composed of sensors both commercially available and in development, will be available for broad scale distribution once tested. Funds are included to support data management activities. (Total funds: $149K -- $119K to NANOOS; $30K to PMEL.) Calibration/validation methodology for the new instruments will be developed cooperatively between PMEL and NANOOS.
2. Application and testing of new observing technologies for ocean acidification observing on deep water moorings off Oregon and Washington (the NH10 and La Push buoys) with an emphasis on high-quality data return and testing of water column sampling technologies. This will likely include the new device being developed by PMEL called the Carbon Prawler – which can use wave energy to winch itself down the mooring line with attached sensors for measurements throughout the water column. These moorings will act as sensor test beds and will be made available to XPrize contestants (and others upon request) as locations for testing the new pH

sensors that prize is targeting. (Total funds: $60K to NANOOS for sub-awards to Oregon State University and University of Washington.)

3. Testing of beta aragonite saturation state prototype monitoring equipment (pCO2 and dissolved inorganic carbon, or DIC) currently being developed by Burke Hales at Oregon State University for use in shellfish operations (indoors) or for running relevant water samples. Central data management ($30K - NANOOS) and onsite trained technical and data assistance ($30K per site) are important aspects of this project. This equipment is currently located at 2 sites (in Oregon at the Whisky Creek Hatchery and Washington State at Taylor Shellfish Hatchery), and will be expanded to three new locations -- two sites in California (Carlsbad Aquafarm, SCCOOS; Hog Island Oyster Company, CeNCOOS) and one site in Southeastern Alaska (Alutiq Pride Shellfish Hatchery, AOOS). (Total funds: $320K – $230K to NANOOS ($200,420 for OSU); $30k for SCCOOS; $30k for CeNCOOS, $30k for AOOS.) Calibration/validation methodology for the new instruments is being developed between Hales, PMEL, and NANOOS.
4. Open water testing off Hawaii of the first remotely deployable, prototype DIC analyzer, developed by PMEL. Working with PacIOOS, researchers will deploy the new buoy and DIC analyzer adjacent to an existing MAPCO_2 buoy that has been on location for the past five years as part of the PacIOOS coastal water quality program. When operated in conjunction with pCO2 monitoring equipment, mineral saturation state can be calculated in real time – an extremely important development. (Total funds: $75K to PacIOOS.)

II. Environmental Sample Processor Deployment in Gulf of Maine

The environmental sample processor (ESP) is a biological sensor capable of measuring harmful algal bloom (HAB) species and their toxins in situ, and communicating these data to shore. The ESP can also be used to detect a variety of other planktonic organisms and some pathogens. The Monterey Bay Aquarium Research Institute (MBARI) developed the ESP, and the ESP is available commercially from McLane Research Laboratories, Inc. Through a National Science Foundation (NSF) Major Research Instrument award to Don Anderson (WHOI), and with additional support from the Environmental Protection Agency, and the U.S. IOOS Program Office, six ESPs were purchased for use in the Gulf of Maine, along with four pressure housings, mooring hardware, and several instruments to provide contextual data. Funding from the NOAA Monitoring and Event Response for Harmful Algal Blooms (MERHAB) Research Program, part of NOAA's National Centers for Coastal Ocean Science (NCCOS), was provided to support a phased deployment of these instruments in the Gulf of Maine that would augment state and federal monitoring programs for HAB-associated illnesses, such as paralytic shellfish poisoning and amnesic shellfish poisoning.

In FY13, funds will accelerate the transition of the ESP technology to full operational use. Funded activities are described below.

1. **Expanded ESP instrument deployment in 2014.** With current MERHAB funding, ESP deployments for the HAB bloom season in 2014 would have been limited to one or two locations along the coast. Funds will allow expansion of the network to four instruments concurrently operating at different locations along the coast. This is a major step towards the ESP array envisioned as part of the Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS), a U.S. IOOS region, observing network and as an integral part of state and federal biotoxin monitoring programs.
2. **Additional contextual sensors.** The ESP is outfitted with two Submersible Ultraviolet Nitrate Analyzer (SUNA) nutrient sensors for measurements of nitrate concentrations in situ, four conductivity temperature depth sensors (CTDs) and one device used to measure the parameters of fluorescence (fluorometer). In order for each ESP mooring to have a full complement of contextual sensors for concurrent measurements, two additional SUNA sensors and three fluorometers will be purchased.
3. **Engineering and software support.** On the engineering side, the nutrient sensors need to be integrated into the communications architecture. Currently, only the CTD is coupled to the ESP, with

the nutrient sensor recording internally, and thus providing no real-time data. The communications architecture includes a port for additional inputs, but engineering time is needed to make this functional. For software development, software advances are needed within the ESP and on the remote server to facilitate data exchange. While the existing communication architecture is well advanced in terms of functionality – using cell phone router technology and a static IP connection to enhance two-way communication with the instrument – MBARI has written a new software package called EXTREMA that would increase this functionality. The funds will support software engineering time to implement this new package.

4. **ESP data portal.** Currently, data from the ESP and its sensors must be processed manually in the laboratory. However, a commercial software package is available that takes data from the ESP and other sensors and mirrors it to an off-site cloud server, with automatic image analysis of spot intensities on the DNA arrays. The system thus processes array and contextual data and generates a range of useful display products in near-real-time. Funds will be used for access to this software package.
5. **Reaction and filter puck design and acquisition.** A major limitation to the duration of ESP deployments is the number of filter, or reaction "pucks", that the instrument can hold. In the current design, 132 pucks are loaded, with three typically used for each measurement. This corresponds to 44 sample analyses per typical deployment. McLane Research designed smaller pucks, increasing the capacity of the ESP. The new design will be tested and the Gulf of Maine instruments retrofitted to accommodate it. If successful, it could nearly double the number of samples that can be taken on a single deployment, allowing for increased sampling coverage of the bloom season while decreasing personnel and ship time costs for instrument recoveries and redeployments.
6. **ESP data integration and website.** Data from ESP moorings will be included in the IOOS data stream using IOOS recommended data standards and services and will be integrated and available through the NERACOOS data portal.
7. **Model integration.** NOAA is transitioning an existing numerical model of *Alexandrium* population dynamics in the Gulf of Maine to operational use as a regional HAB forecasting system. The model is used to provide weekly forecasts to managers, scientists, and other stakeholders in the region. Model simulations, however, need to be validated against measurements of *Alexandrium* population abundance. These comparisons had been possible through regional cruise survey data in the past, but these are no longer supported so other data are now needed for validation. The PI will develop methods to derive a two-dimensional field of cell abundance from a time series of ESP measurements at four fixed locations. The PI will also test data assimilative capabilities in hindcast mode.
   Using ESP data to evaluate accuracy of model forecasts and hindcasts will represent a major step in the modeling and forecasting effort.

For more information about the Ocean Technology Transition project, please contact the Project Manager, Jenifer Rhoades at jenifer.rhoades@noaa.gov.